

EFFECT OF USED FOUNDRY SAND AND MINERAL ADMIXTURES ON STRENGTH PROPERTIES OF CONCRETE

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ABSTRACT

Used foundry sand waste can utilized for the preparation of concrete as partial replacement of sand. The strength properties of M25 grade concrete are studied with different percentages of replacement of sand by used foundry sand for 0%, 10%, 20%, 30%, 40%, and 50%. The optimum percentage of used foundry sand in concrete corresponding to maximum strength will be identified. Keeping this optimum percentage of used foundry sand replacement as constant, cement replacement study with mineral admixtures such as silica fume (5%, 7.5%, 10%) and fly ash (10%, 15%, 20%,) are carried out separately. The maximum increase in strength properties compared to conventional concrete was achieved at 40% replacement of used foundry sand. Test results indicated that replacement of 40% used foundry sand with silica fume showed better performance than with fly ash. The maximum increase in strengths were observed in a mix which consist of 40% used foundry sand with 10% silica fume.

KEYWORDS: Used Foundry Sand, Fly Ash, Silica Flume, Strength Properties

INTRODUCTION

Fundamentally, concrete should be economical, strong, and durable. The construction industry recognizes that considerable improvements are essential in productivity, product performance, energy efficiency and environmental performance. The industry will need to face and overcome a number of institutional competitive and technical challenges. One of the major challenges with the environmental awareness and scarcity of space for land-filling is the wastes/by products utilization as an alternative to disposal. Throughout the industrial sector, including the concrete industry, the cost of environmental compliance is high. Use of industrial by-products such as foundry sand, fly ash, bottom ash and slag can result in significant improvements in overall industry energy efficiency and environmental performance.

The consumption of all type of aggregates has been increasing in recent years in most countries at a rate far exceeding that suggested by the growth rate of their economy or of their construction industries. Artificially manufactured aggregates are more expensive to produce and the available source of natural aggregates may be at a considerable distance from the point of use, in which case, the cost of transporting is a disadvantage. The other factors to be considered are the continued and expanding extraction of natural aggregates accompanied by serious environmental problems. Often it leads to irremediable deterioration of the country side. Quarrying of aggregates leads to disturbed surface area etc., but the aggregates from industrial wastes are not only adding extra aggregate sources to the natural and artificial aggregate but also prevent environmental pollution.

Foundry industry produces a large amount of by-product material during casting process. Commonly foundry sand is used for mould making and is mixture of silica sand (80–95%), bentonite clay (4–10%), carbonaceous additive (2–

10%) and water (2–5%). Green sand (clay bonded sand) also contains some chemical like magnesium oxide (MgO), potassium dioxide (K_2O), titanium dioxide (TiO). About 85% of green sand moulding used for cast iron. Over 70% of the total by-product material consists of sand because moulds usually consist of moulding sand, which is easily available, inexpensive, resistance to heat damage, easily bonded with binder, and other organic material in mould. Foundry industry use high quality specific size silica sand for their moulding and casting process. Foundries successfully recycle and reuse the sand many times in foundry. When it can no longer be reused in the foundry, it is removed from the industry, and is termed as used foundry sand (UFS). It is also known as spent foundry sand (SFS) and waste foundry sand (WFS).

LITERATURE REVIEW

Several authors have reported the use of used foundry sand in various civil engineering applications.

Tarun Naik Et Al [1] and their fellows investigated the performance of fresh and hardened concrete containing discarded foundry sand in place of fine aggregate, Concrete mixes were proportioned to replace 25% and 35% by weight of regular concrete sand with clean/new foundry sand and used foundry sand. The results of this investigation showed that mix containing 25% discarded foundry sand showed about 10% higher compressive strength at 28days than the mix containing 35% discarded foundry sand. However, the compressive strength of the control mix was about 20-30% higher than the mixes containing discarded foundry sands. They added that no marked difference was observed in the density of fresh and hardened concrete.

Han-Young Et Al [2] investigated two types of Foundry Sands like clay bonded sand (CLW) and silicate bonded sand (COW) as a fine aggregate for concrete and basic properties such as air contents, setting time, bleeding, workability and slump loss of the fresh concrete with WFS were tested and compared with those of the concrete mixed without WFS. Also compressive strength and tensile strength of hardened concrete of 28 days were measured. The results showed that (i) flow value and compressive strength of mortar is very rapidly decreased with increasing the replacement ratio of COW and CLW; (ii) Bleeding of concrete with COW, CLW are decreased according to increasing replacement ratio of COW and CLW; (iii) concrete mixed with COW of 30%, compressive and tensile strengths of concrete are higher than those of any other concrete without COW, whereas concrete mixed with CLW, compressive and tensile strengths of concrete are a bit smaller than that of control concrete.

Rafat Siddique Et Al [3] investigated the mechanical properties of concrete mixtures in which fine aggregate was partially replaced with used foundry sand with three percentages 10%, 20% and 30% by weight. Tests were performed for the properties of fresh concrete, compressive strength, splitting tensile strength, flexural strength and modulus of elasticity were determined at 28, 56, 91 and 365 days. Test results showed that increase in compressive strength varied between 8% and 19% depending upon UFS percentage and testing age, whereas it was between 6.5% and 14.5% for splitting tensile strength, 7% and 12% for flexural strength and 5% and 12% for modulus of elasticity.

Saveria Et Al [4] investigated properties of mortars and concrete containing different doses of used foundry sand as partial replacement of sand. The results showed that (i) used foundry sand gives low slump; (ii) mortars containing UFS at water cement ratio equal to 0.5 show a compressive strength lower by about 20-30% compared to that of the reference mix; (iii) the modulus of elasticity doesn't vary significantly; (iv) Drying shrinkage increases with the decrease of mechanical performances.

Khatib and Baig [5, 6] have studied fresh and hardened properties of concrete containing waste foundry sand (WFS) replaced with 0 to 100% with fine aggregate. The water to cement for all mixes was kept constant. Testing on hardened properties was mainly conducted at 14, 28 and 56 days. The results show that the incorporation of waste foundry sand in concrete causes a systematic decreases in workability, ultrasonic pulse velocity and strength and an increase in water absorption and shrinkage of concrete. They also reported that an acceptable concrete strength can be achieved using foundry sand.

Kumbhar Et Al [7] investigated the various mechanical properties of concrete containing used foundry sand. Concrete was produced by replacing natural sand with UFS in various percentages (10%, 20%, 30% and 40%). Based on the test results they concluded that (i) workability goes on reducing with increase in UFS content; (ii) At 28-days, Compressive strength, splitting tensile strength for different replacement levels of UFS is increased whereas flexural tensile strength goes on reducing for UFS content more than 20%; (iii) At 28-days, the modulus of elasticity values increases with replacement of UFS up to 20%. They also concluded that the UFS can be utilized as a replacement to regular sand in concrete up to about 20%.

L Da Silva Et Al and their team [8] investigated the influence of the use of foundry sand waste (FSW) on concrete properties. The properties on the fresh state were evaluated by means of flow table test and the determination of the incorporated air content. On the hardened state, compressive strength tests were performed. Their initial results have shown that the use of FSW leads to an increase in the air content and cracking, caused by expansive reactions. As a result of that, a reduction in the compressive strength has been noticed. They added that the application of mixtures made with FSW becomes risky as to the structural and durability requirements. However they also added that their work may not be generalized, because the FSW composition varies according to the manufacturing process and in all cases it is advisable to carry out preliminary tests in order to verify the effects caused by the use of FSW in the concrete production.

Gurpreet Singh and Rafat Siddique [9, 10] have studied the strength and durability properties of concrete mixtures, in which natural sand was replaced with five percentage (0%, 5%, 10%, and 15% and 20%) of waste foundry sand (WFS) by weight. Compression test and splitting tensile strength test were carried out at the age of 7, 28 and 91 days and Modulus of elasticity, ultrasonic pulse velocity and Rapid Chloride Permeability test were conducted at the age of 28 and 91 days. The abrasion resistance of concrete containing WFS was also investigated. Based on the results obtained they concluded that (i) Maximum increase in compressive strength, splitting tensile strength and modulus of elasticity of concrete was observed with 15% WFS, both at 28 and 91 days; (ii) WFS increases the ultrasonic pulse velocity values and decreased the chloride ion penetration in concrete; (iii) Abrasion resistance of concrete increased with the increase in WFS content. They also added that WFS can be suitably used in making structural grade concrete, as well as for applications where abrasion is also important parameter.

Siddique Et Al. [11] reported the effects on waste foundry sand (WFS) was partial replacement by fine aggregate for the compressive strength and modulus of elasticity of concrete. These properties of concrete were determined in curing of 7, 28, 56, 91, and 365 days with and without waste foundry sand was. That they conclude (i) there were limited improve within the compressive strength of concrete mixtures with the inclusive of foundry sand was partial replacement by sand. At 28 days, Control Aggregate M 1(0%WFS) achieved compressive strength of 28.5MPa, whereas Mixes M 2 (10%FS), M 3 (20%FS), M 4 (30%WFS) achieved compressive strength of 29.7, 30 and 28.3MPa respectively. An increase of 4.2%,

5.2% and 9.8% when compared with the effectiveness of Control Aggregate M 1 (0% WFS). With increase in age (from 56 to 365 days), percentage increase with in compressive strength to control mix (0% WFS) was between 8 to 18%, between 11.4 to 18.8% for mixture M 2, between 12 to 20% for mix M 3, and between 12.4 to 20% for mix M 4. Increase in the compressive strength of concrete mix incorporating of used foundry sand indicated that foundry sand may be successfully used in making concrete as partial replacement of fine aggregate.

Kosmatka Et Al. [12] reported of which higher compressive strength of concrete is essential in increasing the scaling of resistance of concrete. Average compressive strength of 25.13N/mm^2 , 30.75N/mm^2 and 33.85N/mm^2 was reported for three concrete mixtures contain Class F Fly ash, Class C Fly ash and plain cement respectively. They reported of which as the compressive strength improves and scaling of resistance generally improves. The cementitious material from the Class C and class F mixture was 306.75Kg/m^3 and the plain concrete mixture was 281.21Kg/m^3 .

M. Ranjitham Et Al. [13] investigated on strength properties for example compressive strength, split tensile strength and flexural strength of M75 grade of mixtures with different replacement level for example 10%, 20%, and 30% of Used Foundry sand with fine aggregate and 10%, 20%, 30% and replacing cement by mineral admixtures are Fly ash and GGBS slag by adopting water-binder proportion of 0.3. Based on the results shown the replacement of 30% Used Foundry sand with 3% of super plasticiser which usually superior strength characteristics were noticed. They conclude in this study it is been found that adding optimum super plasticizer dose the workability can be reached. For 30% Fly ash and 30% GGBS replacement the fresh properties noticed was good compared to 10%, 20% replacement. Hence Fly ash replacement is effective for HPC to improve high strength. Compared to ordinary concrete M75 grade concrete obtain good strength through the use of lower water/binder proportion. Used Foundry sand and mineral admixtures improve the compressive strength and as well withstanding the maximum load. Compare to Fly ash, GGBS attains good strength as cement replacement.

Research Significance

With ever increasing quantities of industrial byproducts and waste materials, solid waste management has become the principal environmental concerns in the world. Scarcity of landfilling space and due to its ever increasing cost, utilization/recycling of byproducts/waste has become an attractive alternative to disposal. Several types of byproducts and waste materials are generated. Each of these waste products has specific effects on the properties of cement-based materials. The utilization of such materials in concrete not only makes it economical, but also do help in reducing disposal problems. Reuse of bulk wastes is considered the best environmental alternative for solving the problem of disposal. One of such industrial byproducts is used foundry sand. There is a large scale production of used foundry sand from foundry industries in the world. Though used foundry sand has been extensively investigated as constituent materials for strength materials, its possible utilization in concrete has not been investigated thoroughly. In this work, effects of utilization of used foundry sand and mineral admixture on concrete was investigated. The data obtained in this investigation will be used to establish mix proportions for concrete and construction applications.

EXPERIMENTAL PROGRAM

Materials

Ordinary Portland (53 grade) Zuari cement was used, and its properties are given in Table 1. It met the requirements of Indian Standard Specifications IS 12269 -1987 [14]. The properties of the Fly ash and silica fume are given

in Table 2. Locally available river sand was used as a fine aggregate. Used foundry sand was used as a fine aggregate replacement. They were tested as per Indian Standard Specifications IS: 383–1970[15] and their physical properties are given in table 3. Coarse aggregate used in this study were less than 20 mm nominal size, and were tested as per Indian Standard Specifications IS: 383–1970 and its physical properties are given in Table 3.

Table 1: Properties of Cement

Characteristic	Values Obtained	Standard Value as Per iS Code 12269 -1987
Intimal setting time	42 min	Not be less than 30 min
Final setting time	310 min	Not be greater than 600 min
Fineness (%)	4.9	<10
Specific gravity	3.12	-
Compressive strength	56 N/mm ²	Not be less than 53 N/mm ²

Table 2: Properties of Silica Flume and Fly Ash

Characteristics	Fly Ash	Silica Flume
Colour	grey	white
Specific gravity	2.3	2.1
Size (µm)	5.9	<1
Bulk density (Kg/m ³)	994	130-430
Surface area (m ² /kg)	8900	20000

Table 3: Properties of Aggregate

Characteristics	Specific Gravity	Fineness Modulus	Bulk Density(Kg/m ³)
Fine Aggregate	2.57	2.64	1753
Used foundry sand	2.2	1.89	2589
Coarse Aggregate (10 mm)	2.704	6.45	1670
Coarse Aggregate (20mm)	2.825	7.68	1630

Preparation and Casting of Specimens

The different concrete specimens such as cubes (150mmX150mmX150mm) to determine compressive strength, cylinders (150mm diameter and 300mm length) to determine split tensile strength and beams (10mmX10mmX50mm) to determine flexural strength were cast. All the specimens were prepared in accordance with Indian Standard Specifications IS: 516-1959[16]. All the moulds were cleaned and oiled properly. These were securely tightened to correct dimensions before casting. Care was taken that there is no gaps left from where there is any possibility of leakage of slurry. A careful procedure was adopted in the batching, mixing and casting operations. Vibrations were stopped as soon as the cement slurry appeared on the top surface of the mould. The specimens were removed from moulds after 24 hours and cured in water till testing or as per requirement of the test.

Experimental procedure

Experiment investigation has been carried out with reference to mix M25 grade concrete. Twelve mix proportions were prepared. Reference mixture (M0) was prepared for M25 grade of concrete as per IS: 10262-2009[17]. Five concrete mixes (M1, M2, M3, M4, M5) were prepared where fine aggregate was replaced with 10%, 20%, 30%, 40%, and 50% used

foundry sand by mass respectively. It has been observed that concrete with 40% replacement of used foundry sand attains maximum strength properties. Hence 40% replacement of used foundry sand was kept constant and cement replacement study with minerals admixtures such as fly ash at 10%,15%,20% (M6,M7,M8) and silica fume at 5%,7.5%,10% (M9,M10,M11) were carried out separately. A constant water-cement of 0.47 kept for all mixes throughout this study. The mix proportion of all mixes are shown in table 4.

RESULTS AND DISCUSSIONS

Fresh Concrete Properties

The workability of fresh concrete is a composite property which includes the diverse requirements of stability, mobility, compactibility, placeability, and finishability. Compaction factor test is based on the definition, that workability is that property of the concrete that determines the amount of work required to produce full compaction. Compaction factor tests were performed as per BIS: 1199-1959[18]. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction as shown in table 4. As percentage replacement of used foundry sand is increased in concrete its workability decreases.

Table 4: Mixture Proportions

Mix No	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
Cement(Kg/m ³)	419.14	419.14	419.14	419.14	419.14	419.14	377.23	356.27	335.32	398.19	387.79	377.23
Sand (kg)	643.12	578.81	514.5	450.18	385.87	321.56	385.87	385.87	385.87	385.87	385.87	385.87
Foundry sand (%)	0	10	20	30	40	50	40	40	40	40	40	40
Foundry sand(Kg)	0	64.31	128.62	192.93	257.25	321.56	257.25	257.25	257.25	257.25	257.25	257.25
C.A 20mm (Kg)	806.28	806.28	806.28	806.28	806.28	806.28	806.28	806.28	806.28	806.28	806.28	806.28
C.A 10mm (kg)	230.37	230.37	230.37	230.37	230.37	230.37	230.37	230.37	230.37	230.37	230.37	230.37
Water (kg/m ³)	197	197	197	197	197	197	197	197	197	197	197	197
Water/cement	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Compaction factor	0.959	0.942	0.931	0.914	0.87	0.83	0.951	0.948	0.942	0.961	0.958	0.952
Fly Ash (%)	0	0	0	0	0	0	10	15	20	0	0	0
Fly Ash (Kg)	0	0	0	0	0	0	41.91	62.87	83.82	0	0	0
Silica fume (%)	0	0	0	0	0	0	0	0	0	5	7.5	10
Silica fume (Kg)	0	0	0	0	0	0	0	0	0	20.95	31.35	41.91

Compressive Strength

The compressive strength of reference mix (M0) and all other mixes prepared, using used foundry sand and fly ash, silica fume are shown in Table 5.

It was observed that the increase in compressive strength was observed gradually up to 40% replacement of fine aggregates by used foundry sand and then decreased. The maximum compressive strength was obtained 38.70 N/mm² at 40% used foundry sand. Maximum compressive strength was obtained with mix (M4) 40% used foundry sand which was 17.14% more compared reference mix. Variation of compressive strength of M25 grade with different percentage replacement of fine aggregate by used foundry sand is as shown in figure 1.

Compressive strength of M25 grade were studied with combination of 40% used foundry sand and 10%,15%,20% fly ash replaced with cement. Mix with M25 grade with 40% used foundry sand and 10% fly ash obtained maximum strength among all fly ash replacements. It was observed that as fly ash percentage in concrete increased, its compressive strength decreased. Mix which was replaced by 40% of used foundry sand and 10% fly ash (M6) obtained a compressive strength 35.11N/mm² which was 5.124% more than the reference mix (M0).But it was less strength than mix with 40% replacement by used foundry sand (M4). Variation of compressive strength of concrete with 40% used foundry sand and different percentages of fly ash is as shown in figure 2.

Compressive strength of M25 grade were studied with combination of 40% used foundry sand and 5%, 7.5%, 10% silica fume replaced with cement. Mix with M25 grade with 40% used foundry sand and 10% silica fume obtained maximum strength as all silica fume replacements. It was observed that silica fume percentage in concrete increased, its compressive strength also increased. Mix with 40% replacement used foundry sand and 10% silica fume (M11) replacement obtained compressive strength 42.96 N/mm^2 which was 28.738% more than the reference mix. Variation of compressive strength of concrete with 40% used foundry sand and different percentage of silica fume is as shown in figure 3. Percentage of compressive strength of different mixes with reference mix shown are in table 6.

Table 5: Strength Properties of Concrete

Mix No	Compressive Strength in N/mm^2	Split Tensile Strength in N/mm^2	Flexural Strength in N/mm^2
M0	33.03	2.75	2.57
M1	34.98	2.83	2.67
M2	36.60	2.98	2.90
M3	37.88	3.12	3.20
M4	38.70	3.40	3.34
M5	36.13	3.12	3.01
M6	35.11	3.04	2.90
M7	33.85	2.97	2.87
M8	31.29	2.91	2.71
M9	39.82	3.61	3.42
M10	40.71	3.67	3.47
M11	42.96	3.74	3.52

Table 6: Percentages Variation in Strength Properties of Concrete

Mix No	Percentage of Compressive Strength	Percentage of Split Tensile Strength	Percentage of Flexural Strength
M1	5.8813	2.91	3.89
M2	10.785	8.36	12.84
M3	14.659	13.45	24.51
M4	17.14	23.64	29.96
M5	9.3622	13.45	17.12
M6	5.214	10.55	12.84
M7	1.438	8.00	11.67
M8	-6.233	5.82	5.44
M9	19.329	31.27	33.07
M10	21.996	33.45	35.01
M11	28.738	36.00	36.96

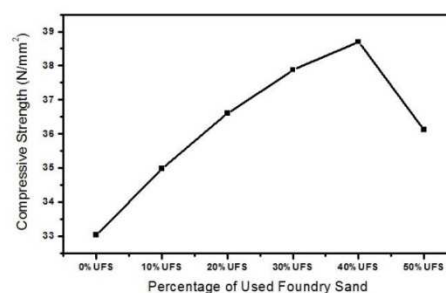


Figure 1: Relation between the Percentages of Used Foundry Sand and Compressive Strength

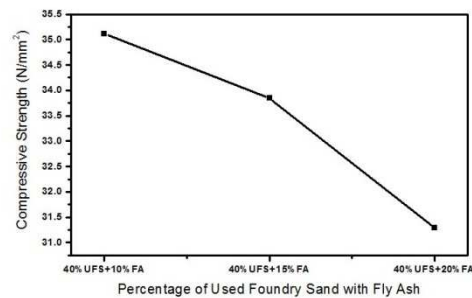


Figure 2: Relation between the Percentages of Used Foundry Sand with Fly Ash and Compressive Strength

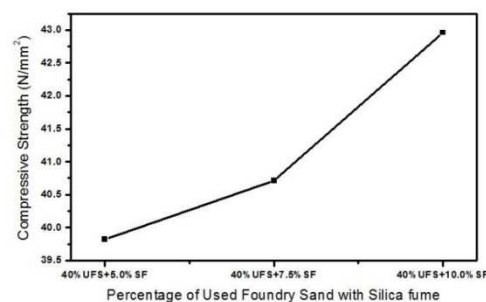


Figure 3: Relation between the Percentages of Used Foundry Sand with Silica Fume and Compressive Strength

Split Tensile Strength

The split tensile strength of reference mix (M0) and all other mixes prepared, using used foundry sand and fly ash, silica fume are shown in Table 5.

It was observed that the increase in split tensile strength was observed gradually up to 40% replacement of fine aggregates by used foundry sand and then decreased. The maximum split tensile strength was obtained 3.40 N/mm^2 at 40% used foundry sand. Maximum split tensile strength was obtained with mix (M4) 40% used foundry sand which was 23.64% more compared reference mix. Variation of split tensile strength of M25 grade with different percentage replacement of fine aggregate by used foundry sand is as shown in figure 4.

Split tensile strength of M25 grade were studied with combination of 40% used foundry sand and 10%,15%,20% fly ash replaced with cement. Mix with M25 grade with 40% used foundry sand and 10% fly ash obtained maximum strength among all fly ash replacements. It was observed that as fly ash percentage in concrete increased, its split tensile strength decreased. Mix which was replaced by 40% of used foundry sand and 10% fly ash (M6) obtained a split tensile strength 3.04 N/mm^2 which was 10.55% more than the reference mix (M0). But it was less strength than mix with 40% replacement by used foundry sand (M4). Variation of split tensile strength of concrete with 40% used foundry sand and different percentages of fly ash is as shown in figure 5.

Split tensile strength of M25 grade were studied with combination of 40% used foundry sand and 5%,7.5%10% silica fume replaced with cement. Mix with M25 grade with 40% used foundry sand and 10% silica fume obtained

maximum strength as all silica fume replacements. It was observed that silica fume percentage in concrete increased, its split tensile strength increased. Mix with 40% replacement used foundry sand and 10% silica fume (M11) replacement obtained split tensile strength 3.74 N/mm^2 which was 36% more than the reference mix. Variation of split tensile strength of concrete with 40% used foundry sand and different percentage of silica fume is as shown in figure 6. Percentage of split tensile strength of different mixes with reference mix shown are in table 6.

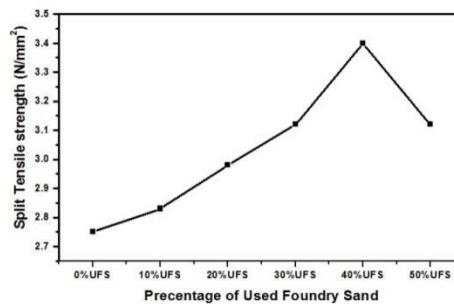


Figure 4: Relation between the Percentages of Used Foundry Sand and Split Tensile Strength

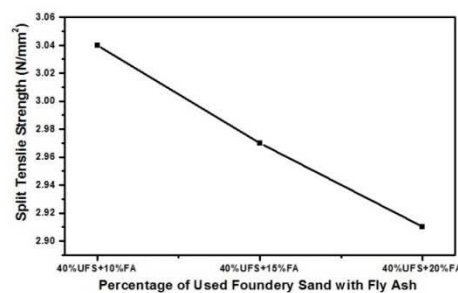


Figure 5: Relation between the Percentages of Used Foundry Sand with Fly Ash and Split Tensile Strength

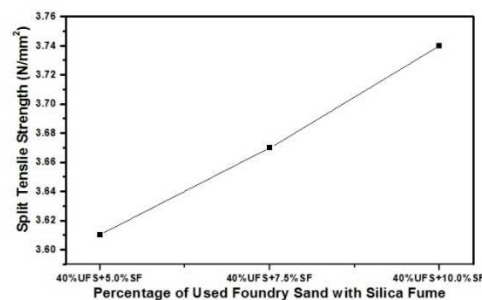


Figure 6: Relation between the Percentages of Used Foundry Sand with Silica Fume and Split Tensile Strength

Flexural Strength

The flexural strength of reference mix (M0) and all other mixes prepared, using used foundry sand and fly ash, silica fume are shown in Table 5.

It was observed that the increase in flexural strength was observed gradually up to 40% replacement of fine aggregates by used foundry sand and then decreased. The maximum flexural strength was obtained 3.34 N/mm^2 at 40% used foundry sand. Maximum flexural strength was obtained with mix (M4) 40% used foundry sand which was 29.96%

more compared reference mix. Variation of flexural strength of M25 grade with different percentage replacement of fine aggregate by used foundry sand is as shown in figure7.

Flexural strength of M25 grade were studied with combination of 40% used foundry sand and 10%,15%,20% fly ash replaced with cement. Mix with M25 grade with 40% used foundry sand and 10% fly ash obtained maximum strength among all fly ash replacements. It was observed that as fly ash percentage in concrete increased, its flexural strength decreased. Mix which was replaced by 40% of used foundry sand and 10% fly ash (M6) obtained a flexural strength 2.9N/mm^2 which was 12.84% more than the reference mix (M0).But it was less strength than mix with 40% replacement by used foundry sand (M4). Variation of flexural strength of concrete with 40% used foundry sand and different percentages of fly ash is as shown in figure 8.

Flexural strength of M25 grade were studied with combination of 40% used foundry sand and 5%,7.5%10% silica fume replaced with cement. Mix with M25 grade with 40% used foundry sand and 10% silica fume obtained maximum strength as all silica fume replacements. It was observed that silica fume percentage in concrete increased, its flexural strength increased. Mix with 40% replacement used foundry sand and 10% silica fume (M11) replacement obtained flexural strength 3.52N/mm^2 which was 36.96% more than the reference mix. Variation of flexural strength of concrete with 40% used foundry sand and different percentage of silica fume is as shown in figure 9. Percentage of flexural strength of different mixes with reference mix shown are in table 6.

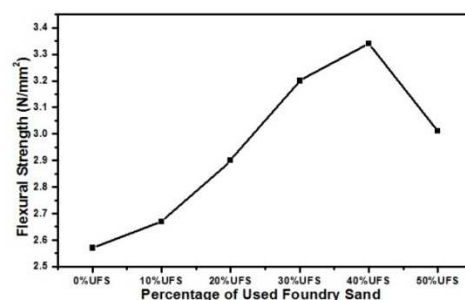


Figure 7: Relation between the Percentages of Used Foundry and Flexural Strength

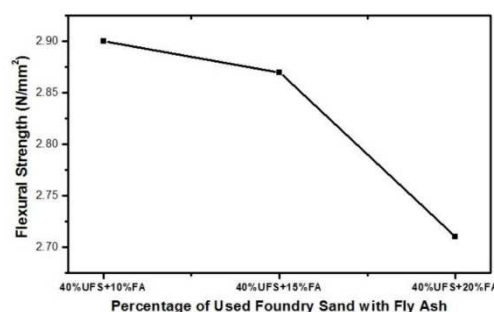


Figure 8: Relation between the Percentages of Used Foundry with Fly Ash and Flexural Strength

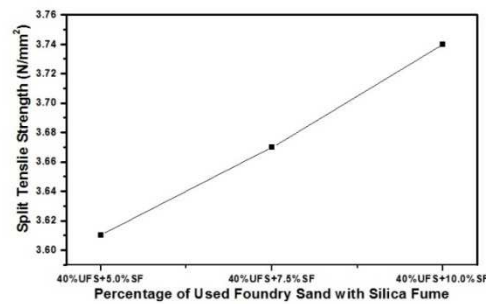


Figure 9: Relation between the Percentages of Used Foundry with Silica Fume and Flexural Strength

CONCLUSIONS

Based on above study, the following observation are made regarding the strength properties of concrete on partial replacement of fine aggregate by used foundry sand and cement by minerals admixture such as fly ash and silica fume.

As percentage of replacement of used foundry sand was increased in concrete, its workability decreases.

It was observed that among all percentages of replacement of fine aggregate by used foundry sand maximum increase in strength occurred at 40% of used foundry sand.

The concrete mix with 40% used foundry sand with 10% silica fume obtained highest strength properties of concrete compared to all other mixes.

The concrete mix with 40% used foundry sand with 10% fly ash obtained more strength properties of concrete compared to reference mix.

Based on experimental results, it is observed that there is significance improvement in the strength properties of concrete with used foundry sand and silica fume combination when compared to used foundry sand and fly ash.

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